CHAPTER 9

INLETS AND BOX DRAINS

9-1. General

a. Materials. Inlet structures to collect storm runoff may be constructed of any suitable construction material. The structures must insure efficient removal of design-storm runoff in order to avoid interruption of operations during or following storms and to prevent temporary or permanent damage to pavement subgrades. Most frequently, reinforced concrete is the material employed although brick, concrete block, precast concrete, or rubble masonry have been used. The use of precast or preformed structures should be encouraged to reduce excavation and backfill for construction and overall expedition of installation. The material, including the slotted drain corrugated metal pipe to handle surface flow if employed, should be of sufficient strength to withstand the loads to which it will be subjected.

b. Locations. Field inlets are usually those located away from paved areas. Box drains, normally more costly than field inlets, are usually located within paved areas to remove surface drainage. Natural drainage of paved areas should be utilized to the greatest extent possible thereby reducing or eliminating the need for paved area inlets.

c. Influences. Local practices and requirements greatly influence design and construction details. Experience has indicated the following features should be considered by the designer.

9-2. Inlets versus catch basins.

Catch basins are not considered necessary where storm drainage lines are laid on self-cleaning grades. Proper maintenance of catch basins is difficult; without frequent cleaning, the sediment basin may quickly be rendered ineffective. Proper selection of storm drain gradients may largely eliminate the need for catch basins. When catch basins are required to prevent solids and debris from entering the drainage system, they must be cleaned frequently. Catch basin installation should be avoided whenever practicable.

9-3. Design features.

a. Elevations. Grating elevations for field inlets must be carefully coordinated with the base or airport grading plan. Each inlet must be located at an elevation which will insure interception of surface runoff. Increased overland velocities immediately adjacent to field inlet openings may result in erosion unless protective measures are taken. A solid sod annular ring varying from 3 to 10 feet around the inlet is effective in reducing erosion if suitable turf is established and maintained on the adjacent drainage area. Paved aprons around the perimeter of a graded inlet should only be considered where extreme erosion or silting conditions exist.

b. Elevation in paved areas. Drainage structures located in the usable areas on airports should be so designed that they do not extend above the ground level. The tops of such structures should be 0.2 of a foot below the ground line (finished grade) to allow for possible settlement around the structure, to permit unobstructed use of the area by equipment, and to facilitate collection of surface runoff.

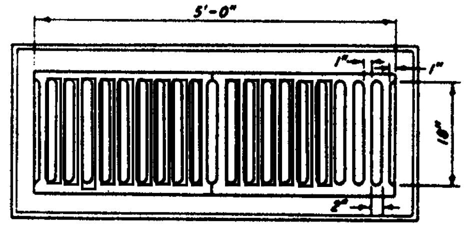
c. Low heads. Under low head situations, a grating in a ponded area operates as a weir. At higher heads the grating acts as an orifice, and model tests of a grating shown in the typical plan of a double inlet grating (fig 9-1) indicates that vortex action influences the discharge characteristics when the head exceeds 0.4 foot. Hydraulically acceptable grates will result if the design criteria in the above figure are applied. For the entire area, the system of grates and their individual capacity will depend on the quantity of runoff to be handled and the allowable head at the grates. Head limitations should not exceed 0.5 foot.

d. Discharge characteristics. Discharge characteristics of gratings are primarily dependent on design and the local rainfall characteristics. A safety factor of 1.5 to 2.0 will be used to compensate for collection of debris on the field gratings in turfed areas. In extensively paved areas, a safety factor of 1.25 may be used in design.

e. Grate materials. Grates may be of cast iron, steel, or ductile iron. Reinforced concrete grates, with circular openings, may be designed for box drains. Inlet grating and frame must be designed to withstand aircraft wheel loads of the largest aircraft using or expected to use the facility. As design loads vary, the grates should be carefully checked for load-carrying capacities. Selection of grates and frames will depend upon capacity, strength, anchoring, or the requirement for single or multiple grates. Suggested designs of typical metal grates and inlets are shown in figures 9-2 and 9-3.

f. Field fabricated grates. Material shortages and construction schedules may require that nonstandard or field fabricated gratings and frames be used in turfed areas. Care should be taken to insure proper loading and tie down is provided in paved areas.

g. Loading. Commercially manufactured grates and frames for airport loadings have been specifically designed for airport loadings from 50 to 250 psi. Hold-down devices have also been designed and are manufactured to prevent grate displacement by aircraft traffic. If manufactured grates are used, the vendor must certify the design load capacity.



TYPICAL PLAN OF DOUBLE INLET GRATING

WATERWAY OPENING = 5.0 SQ. FT. (DOUBLE GRATING)

ASSUME GRATING IS PLACED SO THAT FLOW WILL OCCUR FROM ALL SIDES OF INLET

FOR LOW HEADS DISCHARGE WILL CONFORM WITH GENERAL WEIR EQUATION.

$Q = CLH^{3/2}$

WHERE

$C = 3.0$
$L = 13.0$ FT. GROSS PERIMETER OF GRATE OPENING (OMITTING BARS)
H = HEAD IN FEET

FOR HIGH HEADS DISCHARGE WILL CONFORM WITH ORIFICE FORMULA:

$Q = CA\sqrt{2gH}$

WHERE

$C = 0.6$
$A = 5.0$ SQ. FT.
g = ACCELERATION OF GRAVITY IN FEET PER SECOND^2
H = HEAD IN FEET

THEORETICAL DISCHARGE RELATION TO BE MODIFIED BY 1.25 TO 2.0 SAFETY FACTOR

COEFFICIENTS BASED ON MODEL TESTS OF SIMILAR GRATES WITH RATIO:

NET WIDTH OF GRATE OPENING TO GROSS WIDTH = 2:3

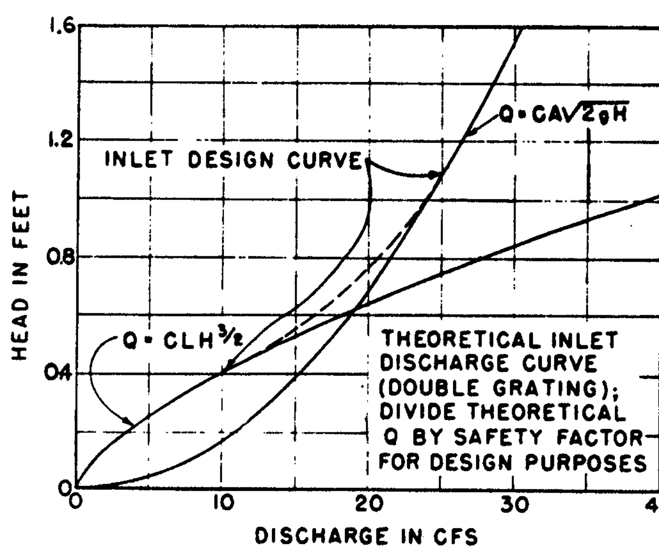


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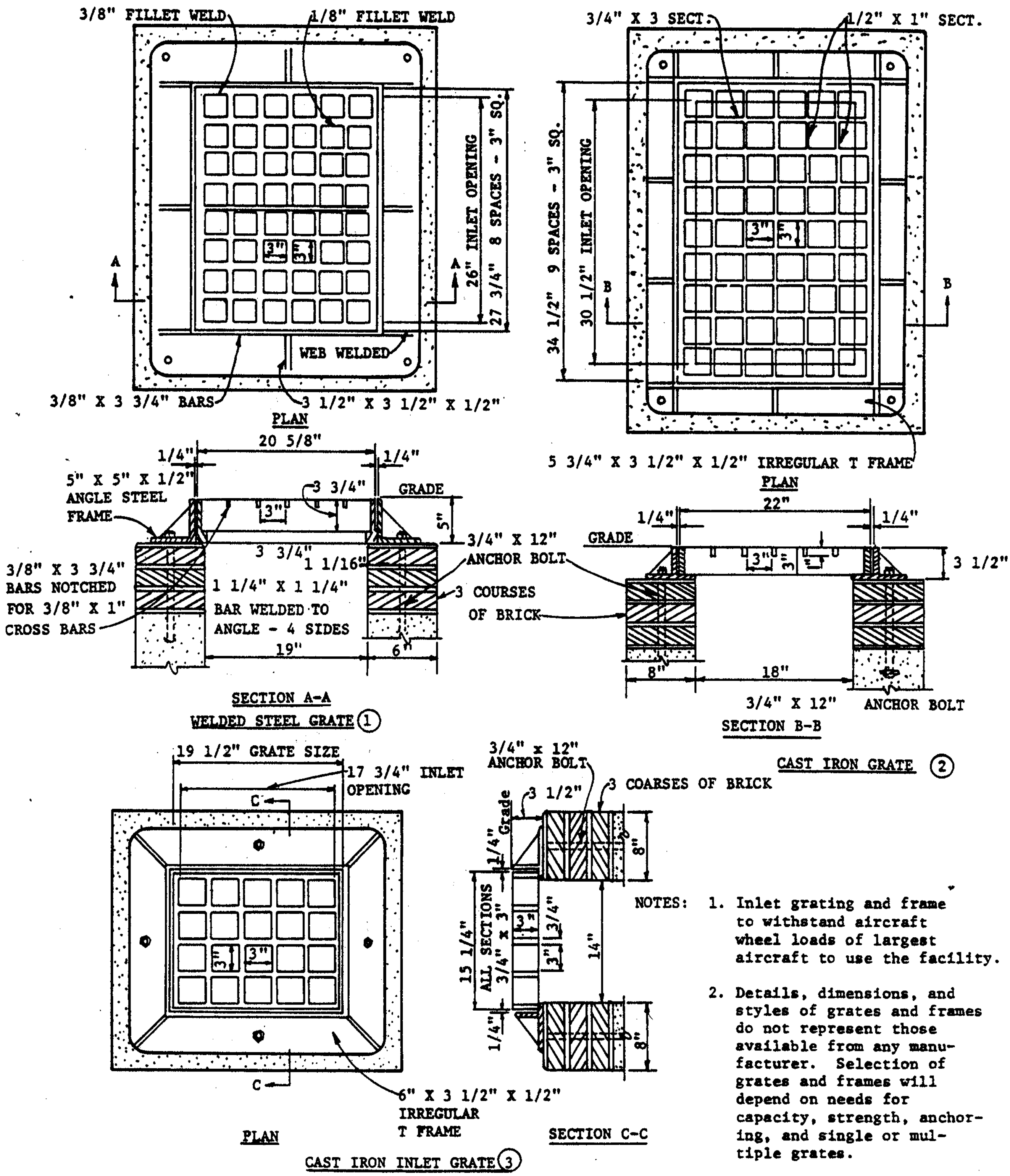
FIGURE 9-1. DETERMINATION OF TYPICAL INLET GRATING DISCHARGE CURVE



NOTES:

1. Inlet grating and frame to withstand aircraft wheel loads of largest aircraft to use the facility.
2. Details, dimensions, and styles of grates and frames do not represent those available from any manufacturer. Selection of grates and frames will depend on needs for capacity, strength, anchoring, and single or multiple grates.

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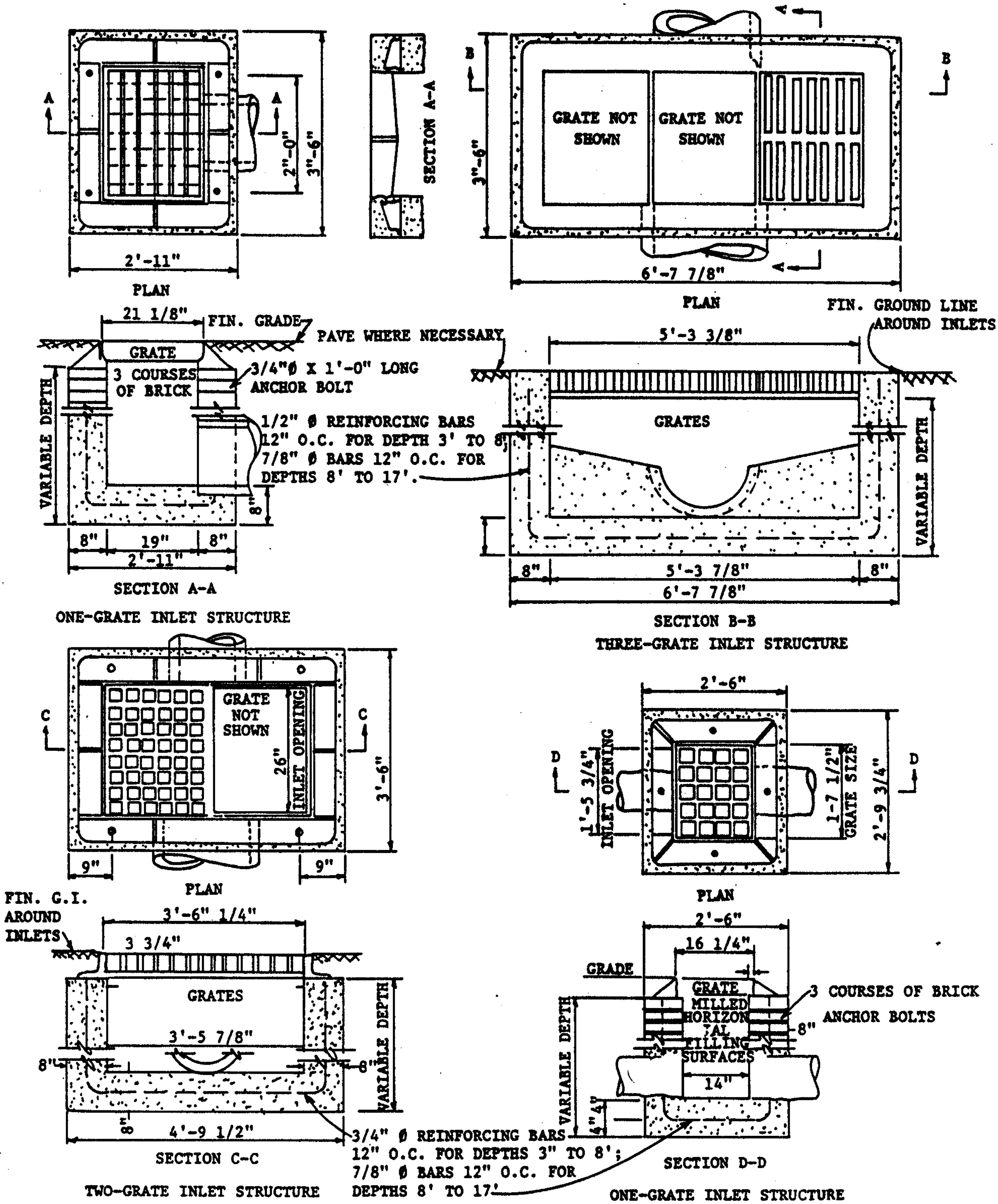
FIGURE 9-2. EXAMPLES OF TYPICAL INLET GRATES



NOTES: Details dimensions, and materials for inlets as well as for grates and frames are illustrative only.

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FIGURE 9-3. EXAMPLES OF INLET DESIGN

h. Configuration. The size and spacing of bars of grated inlets are influenced by the traffic and safety requirements of the local area. Nevertheless, in the interest of hydraulic capacity and maintenance requirements, it is desirable that the openings be made as large as traffic and safety requirements will permit.

i. Construction joints. For rigid concrete pavements, the drainage structure may be protected by expansion joints around the inlet frames. Construction joints, which match or are equal to the normal spacing of joints, may be required around the drainage structure. The slab around the drainage structure should include steel reinforcements to control cracking outwardly from each corner of the inlet.

9-4. Box drains.

a. Design and construction. Where box drains are necessary within paved areas to remove surface drainage, no special inlet structures are required and a continuous-type grating, generally covering the entire drain, is used to permit entrance of water directly into the drain. Box drains are normally more costly and time consuming to construct than conventional inlets. Accordingly, their use will be restricted to unusual drainage and grading situations where flow over pavement surface must be intercepted, such as near hangar doors. The design and construction details of the box drain will depend on local conditions in accordance with hydraulic and structural requirements. However, certain general details to be followed are illustrated by the typical section through a box drain in a paved area shown in figure 9-4. The walls of the box drain will extend to the surface of the pavement. The pavement will have a free thickened edge at the drain. An expansion-joint filler covering the entire surface of the thickened edge of the pavement will be installed at all joints between the pavement and box drain. A 3/4-inch thickness of filler is usually sufficient, but thicker fillers may be required. Grating for box drains can be fabricated of steel, cast iron, or reinforced concrete with adequate strength to withstand anticipated loadings. Where two or more box drains are adjacent, they will be interconnected to provide equalization of flow and optimum hydraulic capacity.

b. Settlement. Inlet drainage structures, particularly box drains, have been known to settle at rates different from the adjacent pavement causing depressions which permit pavement failure should the subgrade deteriorate. Construction specifications requiring careful backfilling around inlets will aid in preventing the differential settling rates.

9-5. Settlement of inlets and drains. Failure of joints between sections of concrete pipe in the vicinity of large concrete manholes indicates the manhole has settled at a different rate than that of the connecting pipe. Flexible joints should be required for all joints between sections of rigid pipe in the vicinity of large manholes,

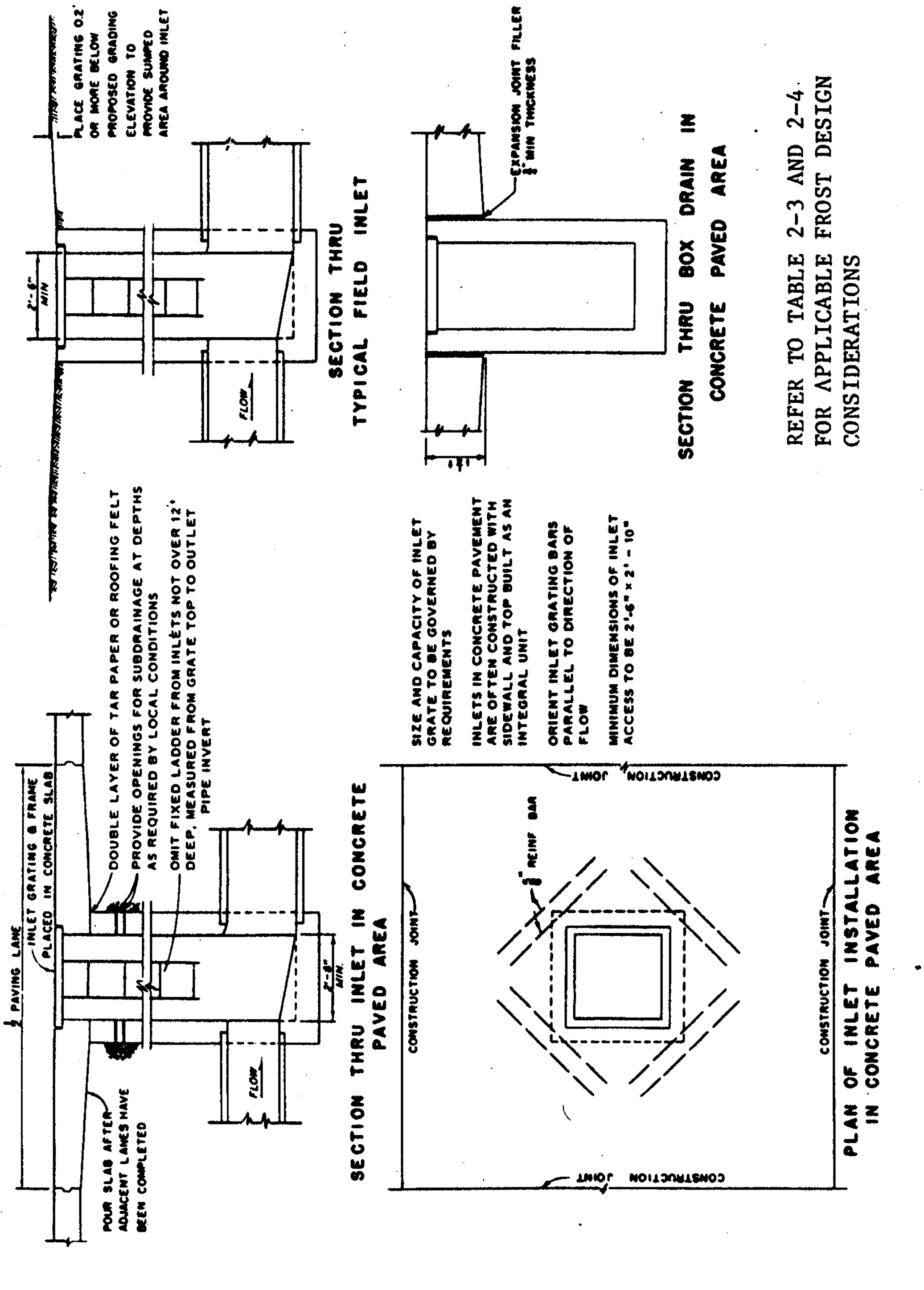

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FIGURE 9-4. TYPICAL INLET AND BOX DRAIN DESIGNS FOR AIRFIELD AND HELIPORT STORM DRAINAGE SYSTEMS approximately three to five joints along all pipe entering or leaving the manhole.